The Coastal Dynamics of Sea Level Rise: A Case Study in the Northern Gulf of Mexico

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Project Overview

The Ecological Effects of Sea Level Rise-Northern Gulf of Mexico (EESLR-NGOM) project will model how sea level rise (SLR) interacts with coastal hydrology to affect coastal species in three National Estuarine Research Reserves (Weeks Bay, Grand Bay, and Apalachicola). This multidisciplinary project builds on field and lab experiments and observations to inform a suite of predictive computer models. Our computer models and field assessments will simulate intertidal marsh evolution and help us project how marshes, seagrass beds, and oyster reefs will respond to SLR.

Coastal Hydrodynamics

Hydrodynamic model results will let us combine various SLR predictions with ecology models, and then extrapolate how both SLR and extreme events might impact coastal regions in the future:

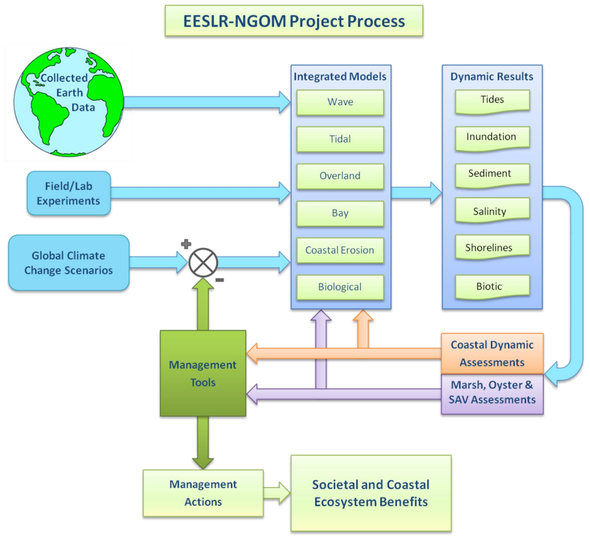
- We develop models to simulate tides, wind waves, and hurricane storm surge for the Mississippi, Alabama and Florida Panhandle coasts and floodplains.
- We use existing models of hydrologic circulation and transport from the watershed (SWAT & WASH123D) to the sea (ADCIRC-2DDI & POM), including waves (SWAN). We also include information from existing bathymetric and topographic data (e.g., LiDAR), field and laboratory experiments, and USGS land use projections.
- We simulate tides, wind waves, and hurricane storm surge for the Mississippi, Alabama and Florida Panhandle coasts and floodplains.
- We then assess hydrodynamic impacts for NOAA SLR scenario guidelines of low, intermediate low, intermediate high and high SLR for 2050 & 2100.

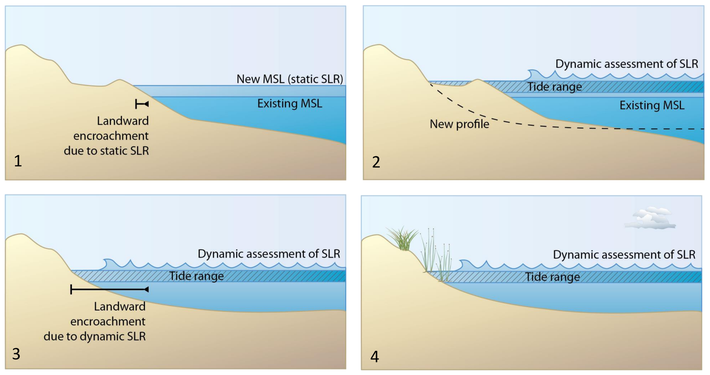
Marsh Plants, Oysters, and Sea Level Rise

Field and laboratory experiments will help us create saltmarsh and oyster habitat models:

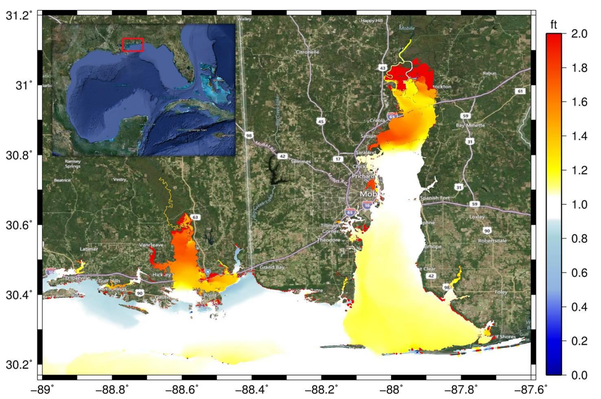
- "Marsh organs" simulate various levels of marsh elevation. Marsh plants thrive when the ground that they grow on is located at a specific elevation between mean high water (MHW) and mean low water (MLW). As sea level rises, so do MHW and MLW. For grasses to remain productive, the buildup of organics and inorganic sediments must keep up with the rate of SLR.
- "Oyster ladders" test the effects of water level and sediments on oyster growth and survival. We are also conducting laboratory experiments that examine oyster sensitivity to sediment grain size and concentration.

The biological models will then be coupled to a tidal hydrodynamic model and an overland flow and sediment model. This gives us the capability to project species' response for multiple climate change scenarios.

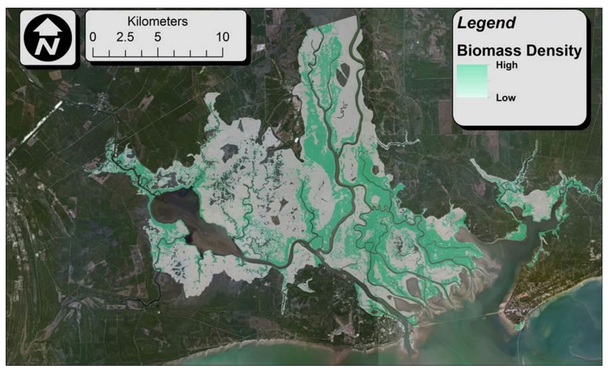




A "bathtub" approach to sea level rise does not capture dynamic effects, which extend beyond just hydrodynamics and include changes to the beach profile. A dynamic approach lets us model coastal complexity and how plants and animals will respond.



Relative change in storm surge if Hurricane Katrina had occurred at one scenario of sea level rise.



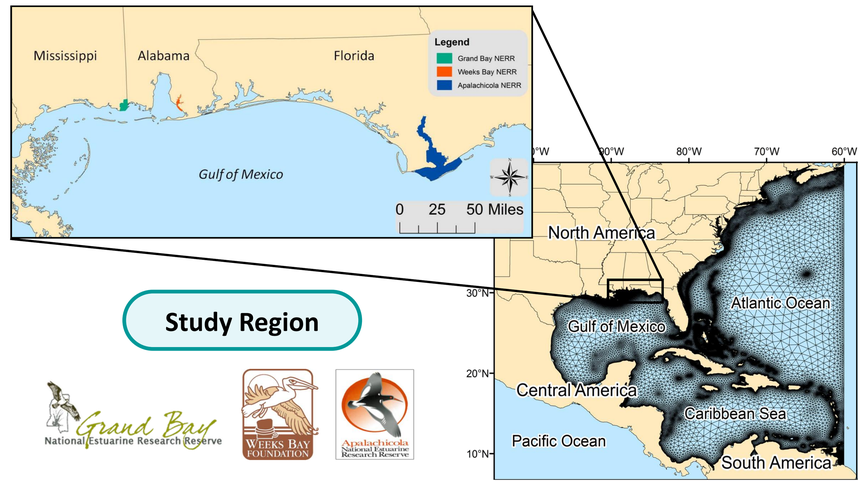
Marsh biomass model, Apalachicola NERR.

The Issue

The combined impacts of rising sea level and tropical storms on Northern Gulf coasts will present a dramatic threat to coastal communities and ecosystems. The effects of SLR will be felt along coastal beaches and in estuaries, affecting barrier islands, submerged aquatic vegetation beds, sand and mud flats, oyster reefs, and tidal and freshwater wetlands.

Resource managers must be aware of the potential consequences of sea level rise. They need the tools to help them adjust their plans accordingly to protect and preserve the resources under their care.

In order to understand and respond to this complex issue, multidisciplinary expertise is needed: coastal engineers, civil engineers, landscape ecologists, marsh ecologists, marine biologists, ecohydrologists, and social scientists.



Study Region

Working with Resource Managers

The final critical component is to ensure that project results are useful for coastal resource managers. The team holds annual stakeholder workshops with resource managers to help us:

- Provide managers an overview of the project and products.
- Learn about noted or expected ecological changes and concerns.
- Solicit input on products' content and format.
- Identify gaps in products, user groups, and target audiences.
- Connect the project with other ongoing SLR research and extension efforts.

Expected Results

The EESLR-NGOM project will provide support for managers as they need to:

- Assess marshes, oyster reefs, and submerged aquatic vegetation.
- Employ future coastal erosion rates and ensure wetland stability.
- Identify restoration locations for marsh and oyster habitats.
- Prioritize risk management strategies, including setback requirements and guidelines for construction of breakwaters and other coastal infrastructure.
- Assess water resource impacts and protection needs.

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